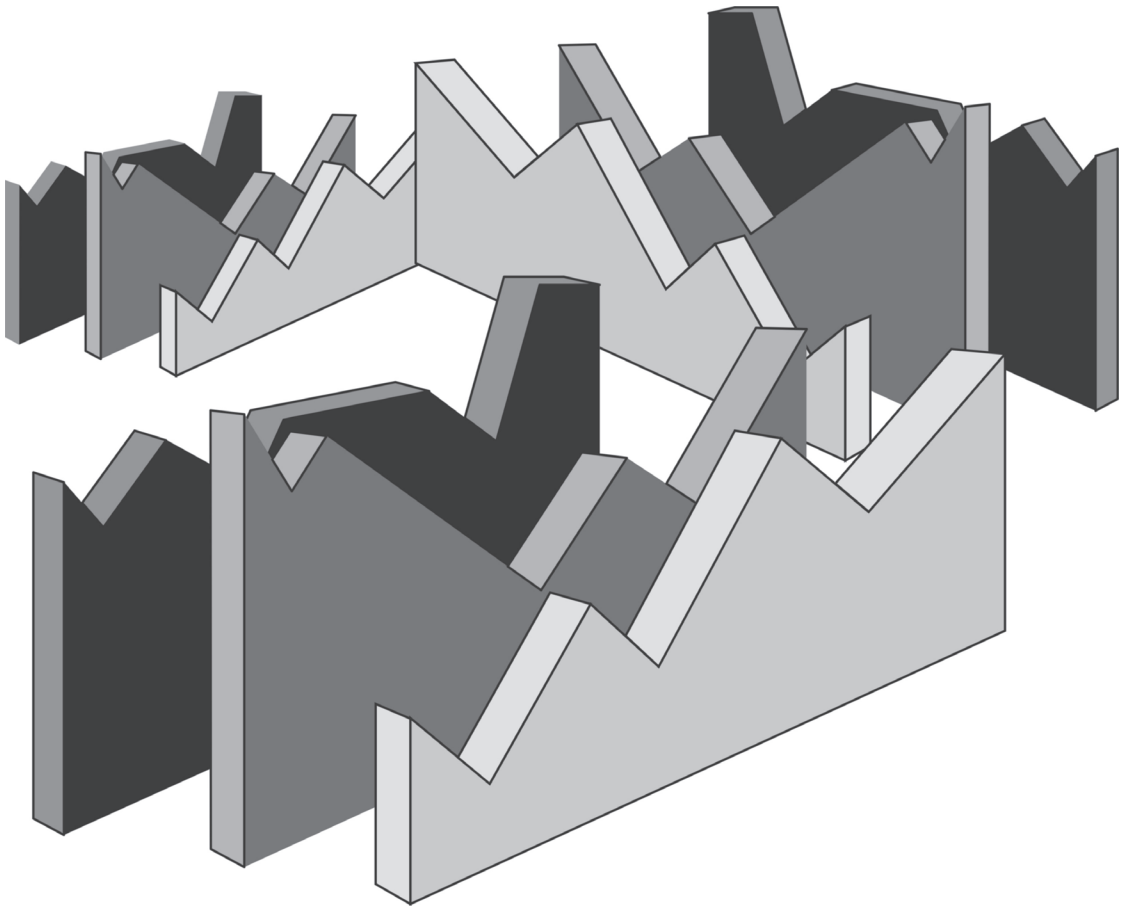
ENERGY ANALYSIS

GENERAL ENERGY

GRADE LEVEL
7–12

SUBJECT AREAS
Science
Social Studies
Math
Technology

Students use graphs of historical data and research historical and societal events to determine and analyze trends in energy.



NEED 2007
Putting Energy into Education
NEED Project PO Box 10101 Manassas, VA 20108 1-800-875-5029 www.NEED.org

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NEED Mission Statement

The mission of the NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

Teacher Advisory Board Vision Statement

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

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TABLE OF CONTENTS

Correlations to National Science Standards 4
Teacher Guide 5-6
Energy Flow Transparency Masters 8-15
Energy Measurements 16
Energy Flow Explanation 16
U.S. Energy Data 17
U.S. Energy Timeline 18
Sample Graphs 19-20
Energy Flow Graphs 21-24
Transportation Graphs 25-28
Evaluation Form 29

FOR A COMPREHENSIVE GLOSSARY OF ENERGY-RELATED TERMS GO TO: www.eia.doe.gov/glossary/index.html

*Energy data come from the Energy Information Administration (EIA) at **www.eia.doe.gov**.*
*Transportation and vehicle data come from EIA and the Bureau of Transportation Statistics at **www.bts.gov**.*

NEED
Putting Energy into Education

Correlations to National Science Standards

(Bolded standards are emphasized in the unit.)

INTERMEDIATE (5-8) STANDARD–B: PHYSICAL SCIENCE

3. Transfer of Energy

a. Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical.

b. Energy is transferred in many ways.

g. The sun is the major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths.

INTERMEDIATE–D: EARTH AND SPACE SCIENCE

3. Earth in the Solar System

b. The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle.

INTERMEDIATE–E: SCIENCE AND TECHNOLOGY

2. Understandings about Science and Technology

c. Technological solutions are temporary and have side effects. Technologies cost, carry risks, and have benefits.

SECONDARY (9-12) STANDARD–F: SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

3. Natural Resources

a. Human populations use resources in the environment to maintain and improve their existence.

b. The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and depletes those resources that cannot be renewed.

c. Humans use many natural systems as resources. Natural systems have the capacity to reuse waste but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

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Teacher Guide

GOAL

TO ENHANCE STUDENTS' CRITICAL THINKING SKILLS BY RESEARCHING AND ANALYZING HISTORICAL DATA AND EVENTS TO DETERMINE AND EXPLAIN ENERGY TRENDS.

BACKGROUND

Students practice graphing data, research historical events, and analyze the graphs in this guide and the Energy Information Administration's *Energy Perspectives* booklet to determine and explain energy trends in the United States during the last 50 years.

TIME

Three to five 45-minute class periods plus outside research and homework.

MATERIALS

- *Energy Perspectives* booklet (also online at www.eia.doe.gov/emeu/aer/contents.html)
- U.S. history textbook as a resource
- NEED's *Secondary Energy Infobook* (individual factsheets are available online at www.need.org)
- Overhead projector

PROCEDURE

Step One—Preparation

- Familiarize yourself with the activity, the **U.S. Energy Flow** diagram on page 15 (explanation on page 16), and with the graphs in this booklet and the *Energy Perspectives* booklet.
- Make copies of the **U.S. Energy Data** sheet and **U.S. Energy Timeline** for each student (pages 17-18).
- Make copies of the graphs you want the students to analyze from this booklet (pages 21-28) and the *Energy Perspectives* booklet. *(You can have all of the students use the same graphs and conduct classroom discussions or assign groups of students to different sets of graphs and have them make presentations to the class.)*
- Make copies of the pages you have chosen from NEED's *Secondary Energy Infobook* or obtain a class set of infobooks for the students to use by calling NEED at 1-800-875-5029. Individual factsheets are also available online at ***www.need.org/guides.htm***.
- Make transparencies of the **Energy Flow 2006** progressive diagram on pages 8-15 and the sample graphs on pages 19-20.

Step Two—Introduction: Energy Yesterday, Today and Tomorrow

- Introduce the activity by discussing with the students how energy has been used throughout the history of the United States, the changing energy sources that have been used, the energy sources we use today and the purposes for which they are used, the major historical events that have had an effect on energy, and how the future energy picture might change.
- Use the **Energy Flow** transparencies and explanation to give an overview of energy consumption and production.

- Distribute the **U.S. Energy Timeline** and **U.S. Energy Data** sheets to the students.
- Discuss how the students can graphically compare aspects of the data to determine energy trends.
- Discuss the historical events listed that have significantly affected the energy trends in the U.S.

Step Three—Graphing Data

- Have the students create graphs in class and as homework to answer the following questions:

  How has per capita consumption of energy changed in the last 50 years?

  How has the percentage of energy we import from other countries changed in the last 50 years?

  How has the mix of energy sources changed in the last 50 years in production and consumption considering fossil fuels, uranium (nuclear) energy and renewable energy sources?

- Check the students' graphs for accuracy and understanding. Use transparencies of the sample graphs and discuss the answers to the questions.

Step Four—Analyzing Data and Determining Energy Trends (pages 21–28)

- Explain the assignment—the students will analyze the information in the graphs, determine the trends that are implied by the information, and research historical events that may have affected or may affect those trends.

Option One: All Students Analyzing the Same Graphs

- If all of the students are assigned the same graphs, distribute the background information and sets of graphs you have chosen, and have each student write an explanation of the graphs, the trends and the significant historical events. Allow them to begin the assignment in class and give them several days to complete the assignment as homework.
- Discuss the assignment upon completion to develop a consensus within the group.

Option Two: Groups of Students Analyzing Different Sets of Graphs

- If the students are working in groups to analyze different sets of graphs, divide the students into groups and distribute the background information and sets of graphs you have chosen for them to analyze. Explain that each group will prepare a five-minute presentation for the class to explain the graphs, the trends, and the significant historical events. Allow the groups to begin the assignment in class and give them several days to complete the assignment, either as homework or as class work.
- Monitor group work.
- Have each group make its presentation.
- Discuss the assignment upon completion to develop an overall sense of what will happen in the energy sector in the near future and possible events that could have an effect that direction.

Technology Connection

- Have the students conduct web-based research and prepare PowerPoint presentations on one aspect of energy and how its use has changed in the last fifty years.

Step Five—Evaluation

- Evaluate individual and group work according to your own expectations.
- Evaluate the activity with the students using the Evaluation Form on page 29 and send to NEED.

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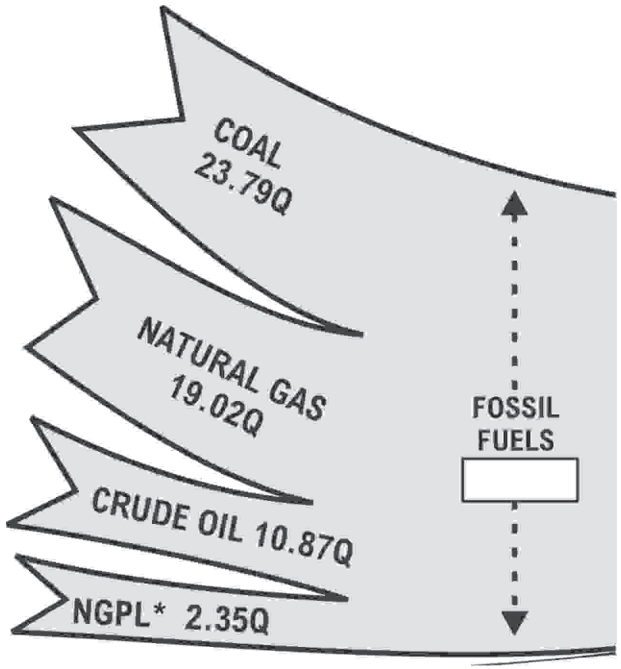
U.S. ENERGY FLOW 2006
PROGRESSIVE
FLOW CHART
PAGES 8-14

COMPLETE FLOW CHART
PAGE 15

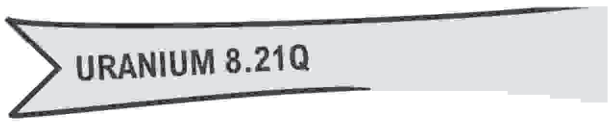
FOR A COMPREHENSIVE GLOSSARY OF ENERGY-RELATED TERMS GO TO:

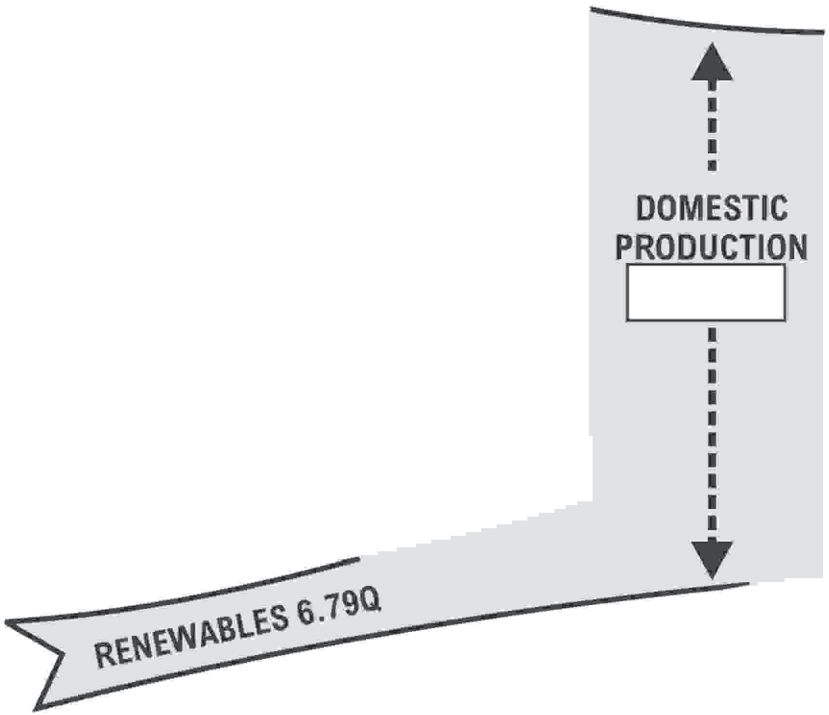
www.eia.doe.gov/glossary/index.html

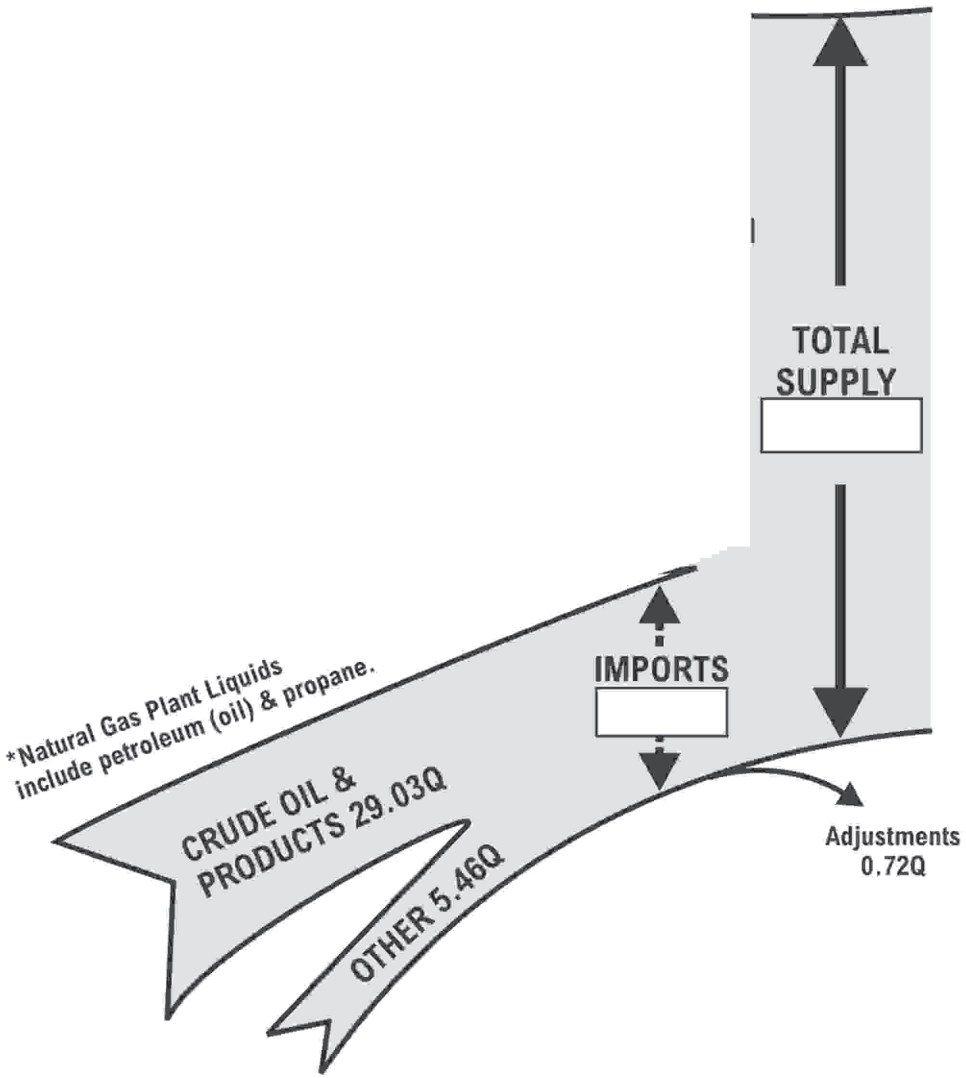


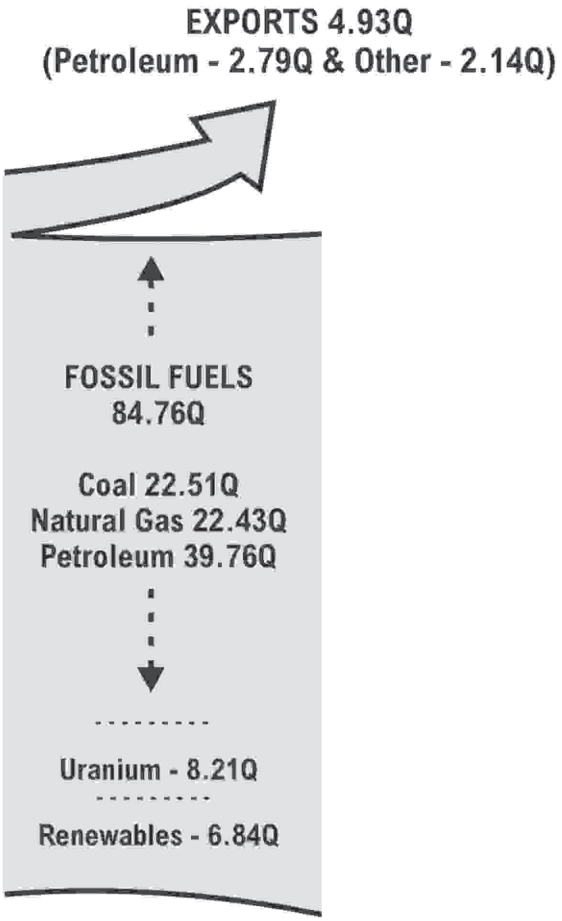
U.S. ENERGY FLOW 2006

PRODUCTION → CONSUMPTION

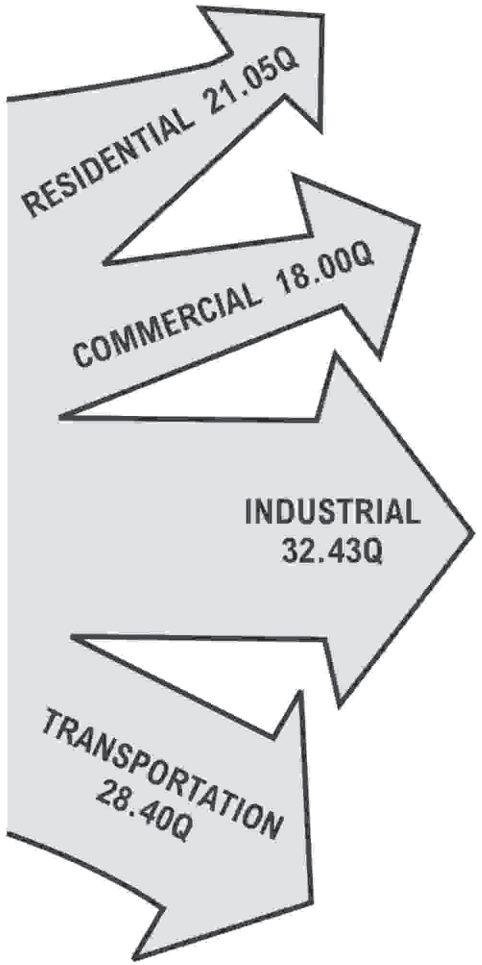

URANIUM 8.21Q

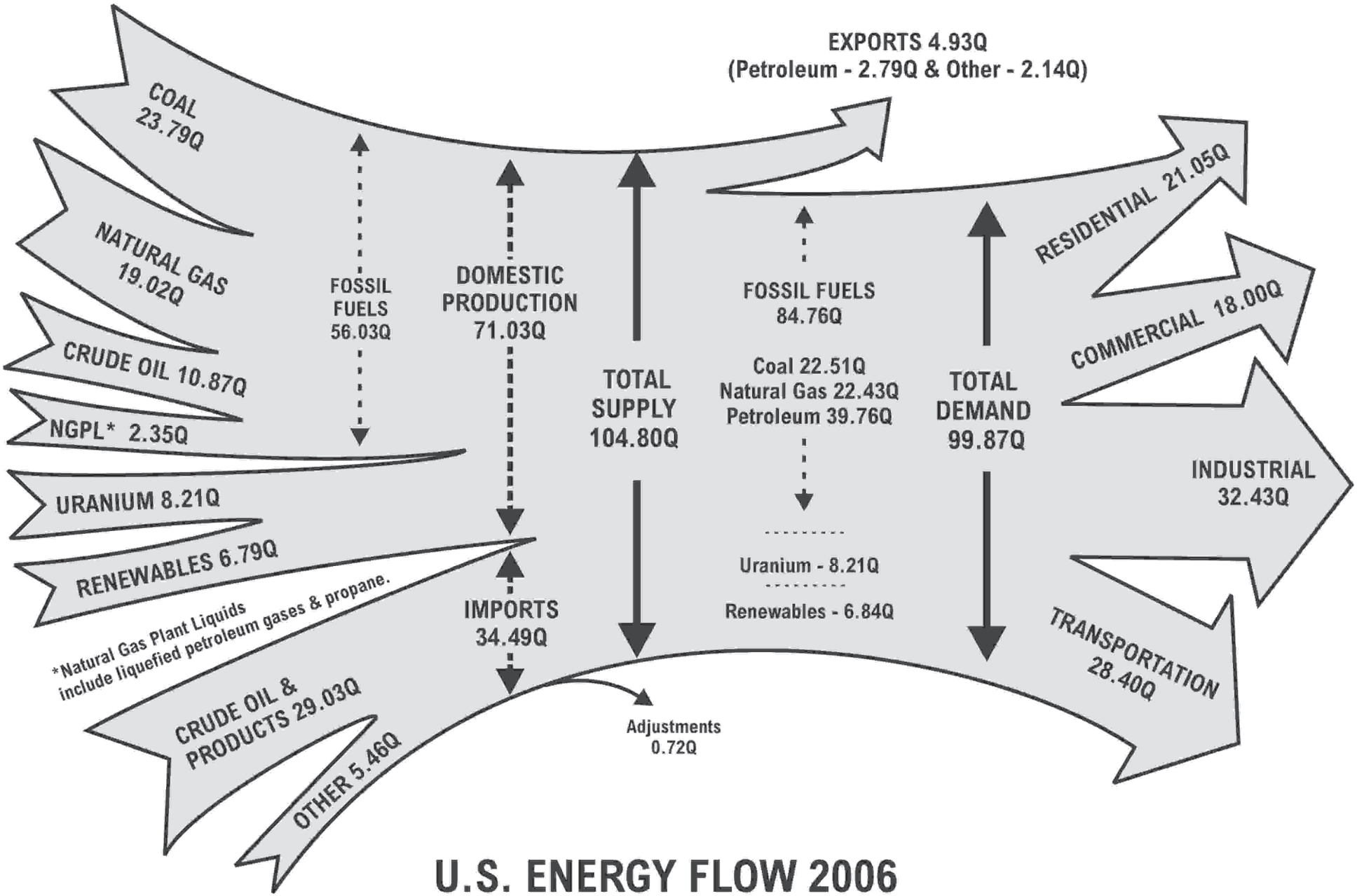

DOMESTIC
PRODUCTION
RENEWABLES 6.79Q


TOTAL
SUPPLY
IMPORTS
*Natural Gas Plant Liquids
include petroleum (oil) & propane.
CRUDE OIL &
PRODUCTS 29.03Q
OTHER 5.46Q
Adjustments
0.72Q


EXPORTS 4.93Q
(Petroleum - 2.79Q & Other - 2.14Q)
FOSSIL FUELS
84.76Q
Coal 22.51Q
Natural Gas 22.43Q
Petroleum 39.76Q
Uranium - 8.21Q
Renewables - 6.84Q

TOTAL
DEMAND


RESIDENTIAL 21.05Q
COMMERCIAL 18.00Q
INDUSTRIAL
32.43Q
TRANSPORTATION
28.40Q


EXPORTS 4.93Q
(Petroleum - 2.79Q & Other - 2.14Q)
COAL
23.79Q
NATURAL GAS
19.02Q
CRUDE OIL 10.87Q
NGPL* 2.35Q
URANIUM 8.21Q
RENEWABLES 6.79Q
*Natural Gas Plant Liquids include liquefied petroleum gases & propane.
CRUDE OIL & PRODUCTS 29.03Q
OTHER 5.46Q
FOSSIL FUELS 56.03Q
DOMESTIC PRODUCTION 71.03Q
IMPORTS 34.49Q
TOTAL SUPPLY 104.80Q
Adjustments 0.72Q
FOSSIL FUELS 84.76Q
Coal 22.51Q
Natural Gas 22.43Q
Petroleum 39.76Q
Uranium - 8.21Q
Renewables - 6.84Q
TOTAL DEMAND 99.87Q
RESIDENTIAL 21.05Q
COMMERCIAL 18.00Q
INDUSTRIAL 32.43Q
TRANSPORTATION 28.40Q
U.S. ENERGY FLOW 2006
PRODUCTION
CONSUMPTION

ENERGY MEASUREMENTS

1 cal = Calorie—a measure of heat energy—the amount of heat energy needed to raise the temperature of one gram of water by one degree Celsius.

1 cal = 4.187 joules

1 Btu = British thermal unit—a measure of heat energy—the amount of heat energy needed to raise the temperature of one pound of water by one degree Fahrenheit. One Btu is approximately the amount of energy released by the burning of one wooden kitchen match.

1 Btu = 1,054 joules

1 Btu = 252 calories

1 Q = Quad—1 quadrillion Btu. Quads are used to measure very large quantities of energy. The U.S. uses one quad of energy about every 3.7 days.

1 therm = 100,000 Btu; approximately the amount of heat energy in one CCF of natural gas.

1 kWh = Kilowatt-hour—one kilowatt of electricity over one hour. One kilowatt-hour of electricity is the amount of energy it takes to burn a 100 watt light bulb for 10 hours. The average cost of one kilowatt-hour of electricity for residential customers in the U.S. is about nine cents.

1 kWh = 3.6 million joules (3.6 Mj).

1 kWh = 3,412 Btu

1 CF = Cubic foot—a measure of volume—one CF of natural gas contains about 1,020 Btu.

1 CCF = One hundred cubic feet—one CCF of natural gas contains about one therm of heat energy.

1 MCF = One thousand cubic feet—one MCF of natural gas for residential consumers costs $10–13.

ENERGY FLOW DIAGRAM EXPLANATION

The left side of the diagram shows energy production by source (supply) and imports figures for 2006 in the U.S.:

The top four on the list—coal, natural gas, crude oil, and NGPL—are fossil fuels that provided 56.03 quads of energy.

Uranium (nuclear) produced 8.21 quads of energy.

Renewables (solar, wind, hydropower, geothermal, and biomass) produced 6.79 quads of energy.

The bottom two show imports—mostly crude oil and petroleum products that produced 29.03 quads of energy, while all other imported energy produced 5.46 quads of energy.

The adjustment figure is a 'balancing' figure so that both sides of the graph are equal and includes uncounted inputs.

The diagram shows that most of 2006 U.S. energy supply came from fossil fuels and that the U.S. imported 33% of its total energy supply.

The right side of the diagram shows energy consumption figures by energy source and sector of the economy:

The U.S. exported 4.93 quads of energy in 2006.

The residential sector (homes) consumed 21.05 quads of energy or 21.1% of total energy consumption.

The commercial sector (businesses) consumed 18.00 quads of energy or 18.0% of total energy consumption.

The industrial sector (manufacturing) consumed 32.43 quads of energy or 32.5% of total energy consumption.

The transportation sector (vehicles) consumed 28.40 quads of energy or 28.4% of total energy consumption.

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U.S. HISTORICAL ENERGY DATA

BASIC ENERGY INFORMATION

DATE	POPULATION	PRODUCTION *(in quads)*	CONSUMPTION *(in quads)*
1950	151,326,000	35.6	34.6
1960	179,323,000	42.8	45.1
1970	203,302,000	63.5	67.8
1980	226,542,000	67.2	78.3
1990	248,422,000	70.7	84.6
2000	281,422,000	71.2	98.9
2006	299,398,000	71.0	99.9

ENERGY PRODUCTION BY SOURCE (in quads)

DATE	COAL	NATURAL GAS	PROPANE	PETROLEUM (OIL)	URANIUM (NUCLEAR)	RENEWABLES
1950	14.1	6.2	0.4	11.9	0	3.0
1960	10.8	12.7	0.8	15.6	0	2.9
1970	14.6	21.7	1.2	21.7	0.2	4.1
1980	18.6	19.9	1.4	19.1	2.7	5.5
1990	22.5	18.3	1.2	16.5	6.1	6.1
2000	22.6	19.7	1.9	12.9	7.9	6.2
2006	23.8	19.0	1.8	11.4	8.2	6.8

ENERGY CONSUMPTION BY SOURCE (in quads)

DATE	COAL	NATURAL GAS	PROPANE	PETROLEUM (OIL)	URANIUM (NUCLEAR)	RENEWABLES
1950	12.3	6.0	0.3	13.0	0	3.0
1960	9.8	12.4	0.7	19.3	0	2.9
1970	12.3	21.8	1.1	28.3	0.2	4.1
1980	15.4	20.4	1.3	33.0	2.7	5.5
1990	19.2	19.7	1.1	32.4	6.1	6.1
2000	22.6	24.0	1.8	36.4	7.9	6.2
2006	22.6	21.6	1.9	38.8	8.2	6.8

U.S. ENERGY TIMELINE

1953	First atomic reactor to produce power began operation in Idaho
1954	Demonstration of a solar cell by Bell Laboratory
1954	Atomic Energy Act enacted
1956	First coal pipeline constructed to move mixture of coal and water
1957	First nuclear power plant began operation in Pennsylvania
1959	First fuel cell designed to produce electricity from hydrogen and oxygen
1960	OPEC - Organization of Petroleum Exporting Countries - established to control oil production
1960	First geothermal power plant began operation in California
1965	Fuel cells were used in the space program
1965	Recycling program started for aluminum cans
1967	Short-lived Arab oil embargo to protest Six Day War
1968	Wild and Scenic Rivers Act enacted
1969	Oil discovered on Alaska's North Slope
1970	Environmental Protection Agency created
1970	First waste-to-energy plant began operation
1973	Arab oil embargo to protest Arab/Israeli War
1973	Gasoline rationing began
1973	Plastic bottles began to replace glass; plastic recycling began
1974	55 mile per hour speed limits imposed
1974	Arab oil embargo lifted
1976	Electric Vehicle Act enacted
1977	Trans-Alaska oil pipeline opened
1977	Strategic Petroleum Reserve began
1977	Department of Energy created
1978	National Energy Act and PURPA (Public Utility Regulatory Policies Act) enacted
1978	Iranian Revolution shut down oil exports
1979	Nuclear accident occurred at Three Mile Island Nuclear Power Plant in Pennsylvania
1979	OPEC raised crude oil prices—oil prices triple between January 1979 and September 1980
1979	President Carter announced effort to reduce dependence on foreign oil
1980	First solar photovoltaic (PV) power plant opened in Utah
1981	Price controls ended on crude oil and petroleum products
1982	First solar-thermal power plant opened in California
1983	OPEC lowered price of crude oil for first time
1988	Vertical-blade turbine began producing electricity in Hawaii
1989	Exxon Valdez oil tanker spilled 240,000 barrels of crude oil in Alaska's Prince William Sound
1987	Shippingport Atomic Power Station decommissioned
1989	High efficiency PV cells developed
1990	Iraq invaded Kuwait causing crude oil price increase
1998	Electric utility deregulation began
2003	Invasion of Iraq disrupted crude oil supplies
2003	Major electricity blackout occurred in the Northeast
2006	Oil prices reach new high

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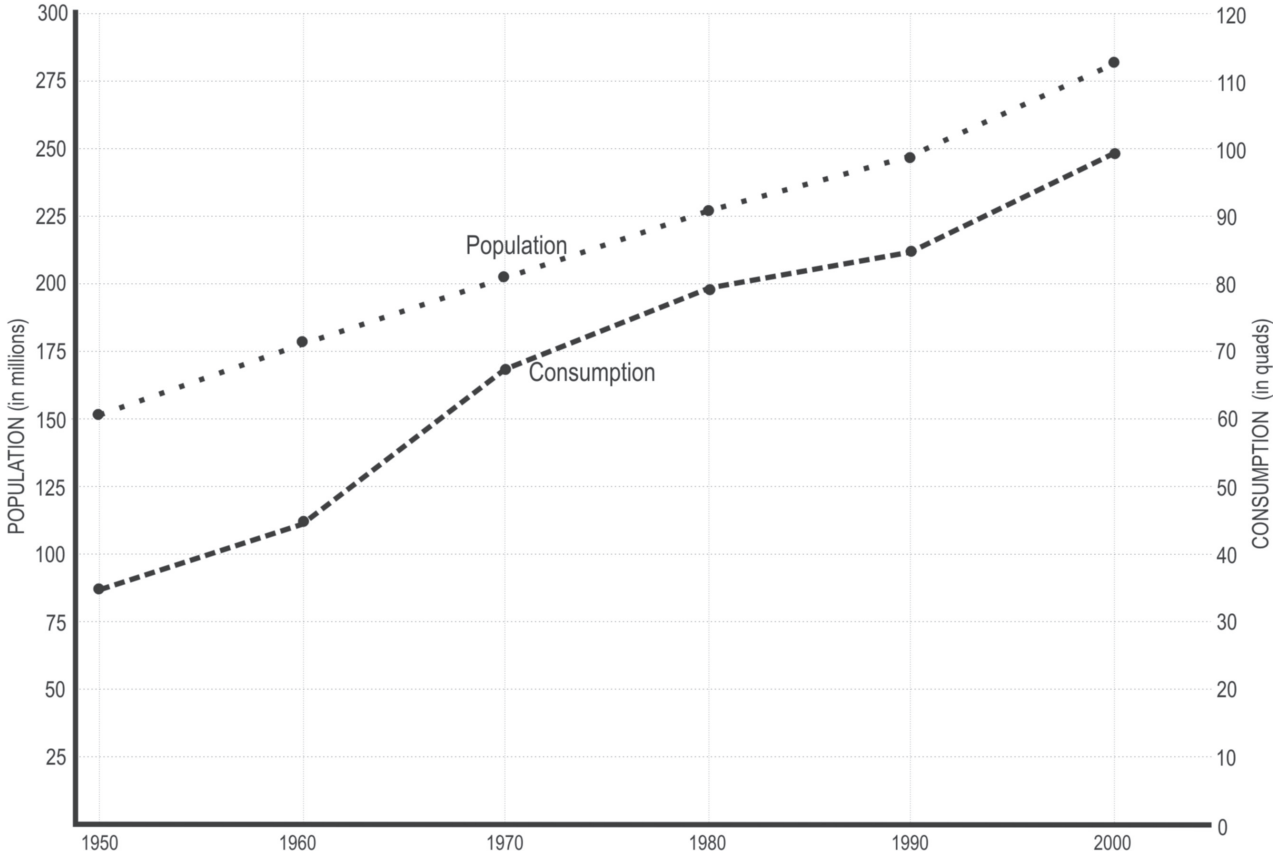
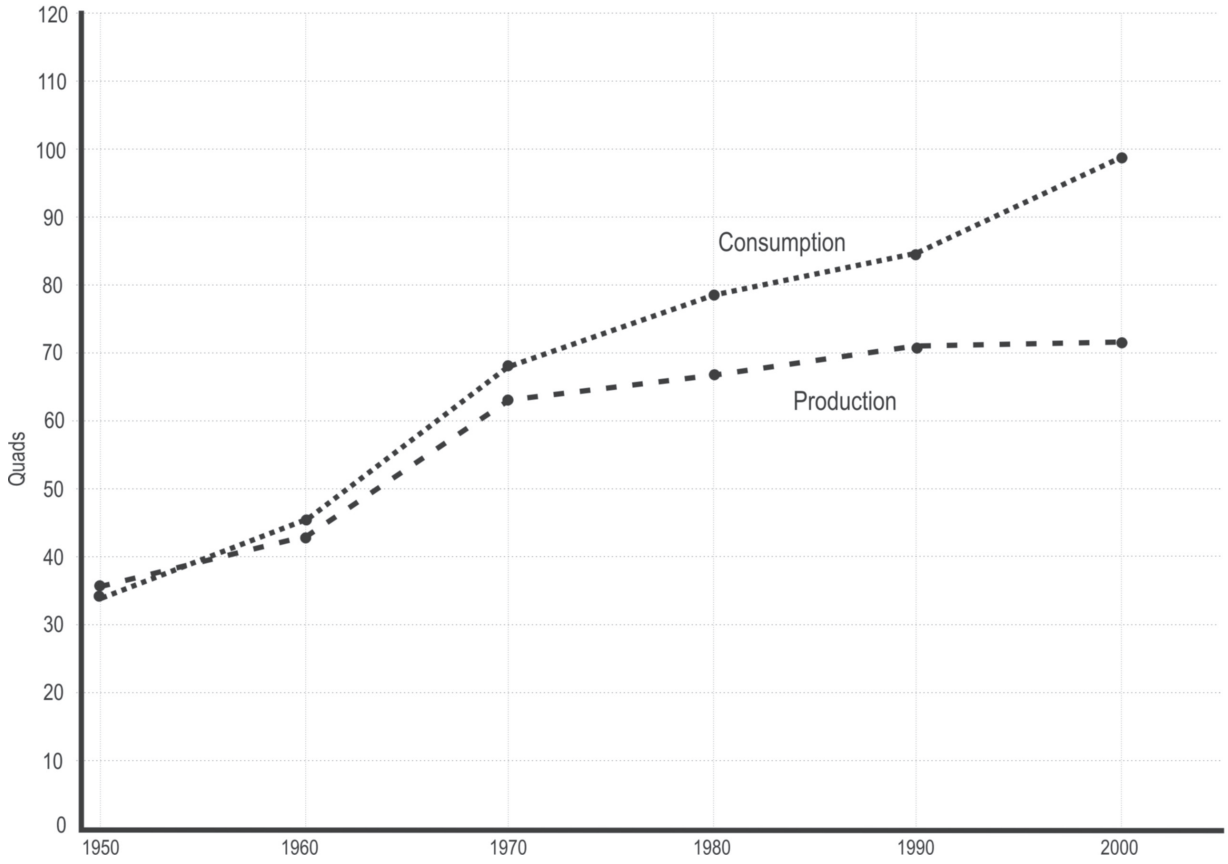
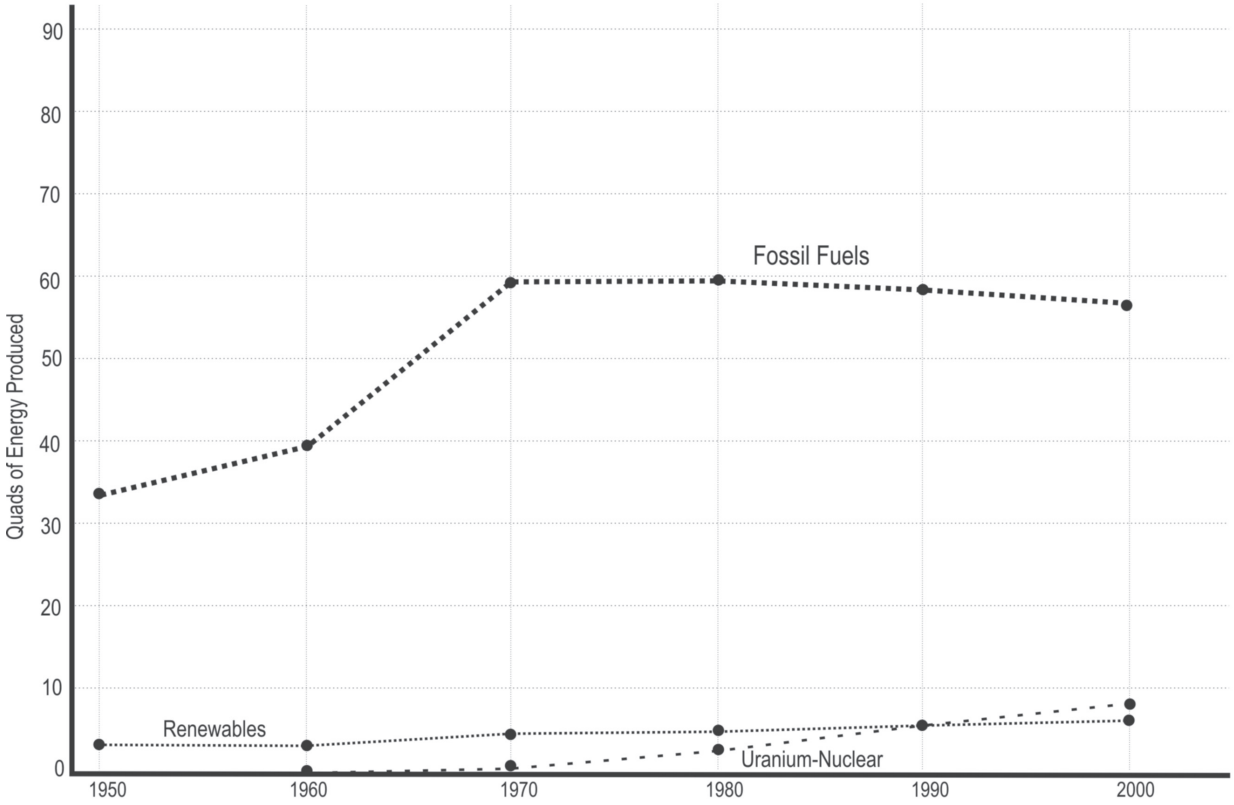
U.S. POPULATION vs ENERGY CONSUMPTION



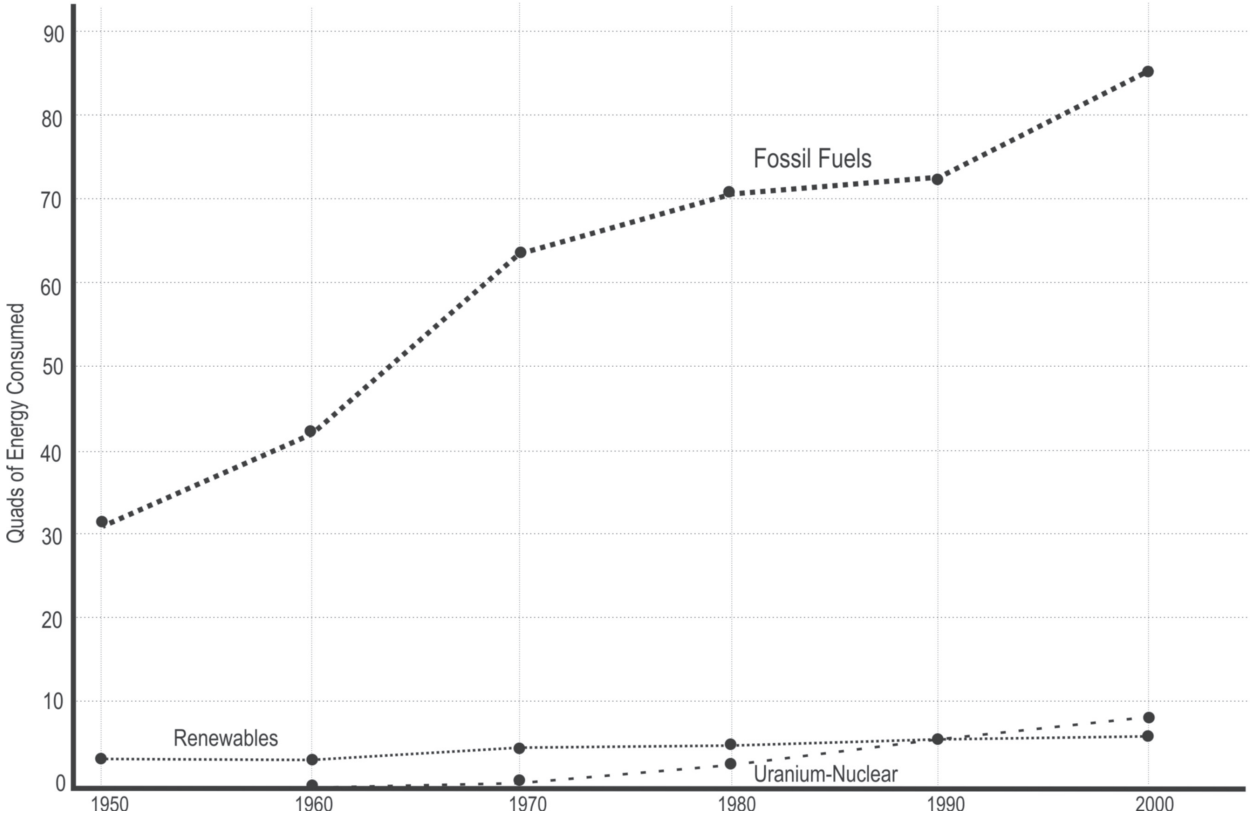
U.S. ENERGY PRODUCTION vs CONSUMPTION



U.S. PRODUCTION BY ENERGY SOURCE



U.S. CONSUMPTION BY ENERGY SOURCE



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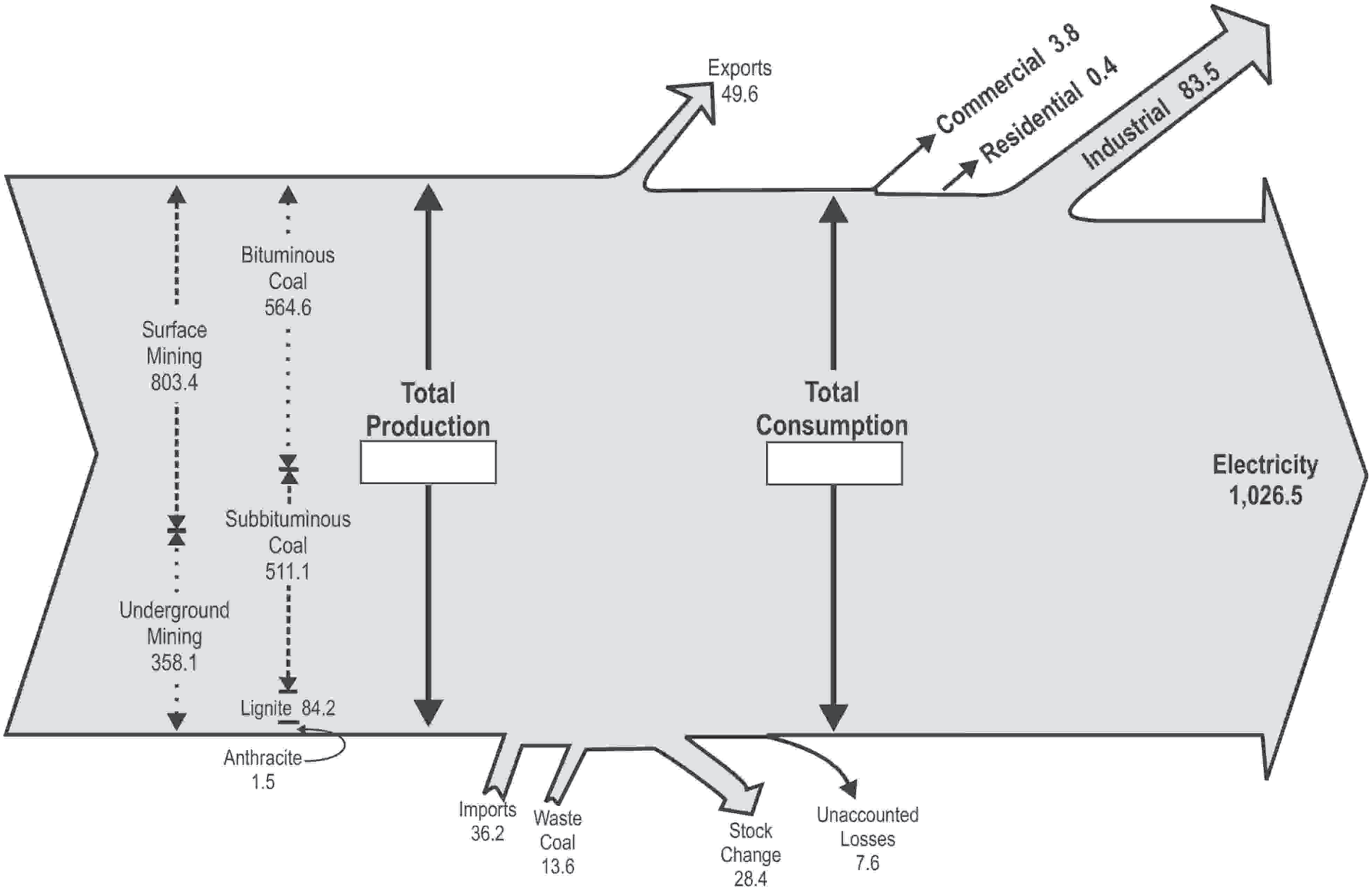
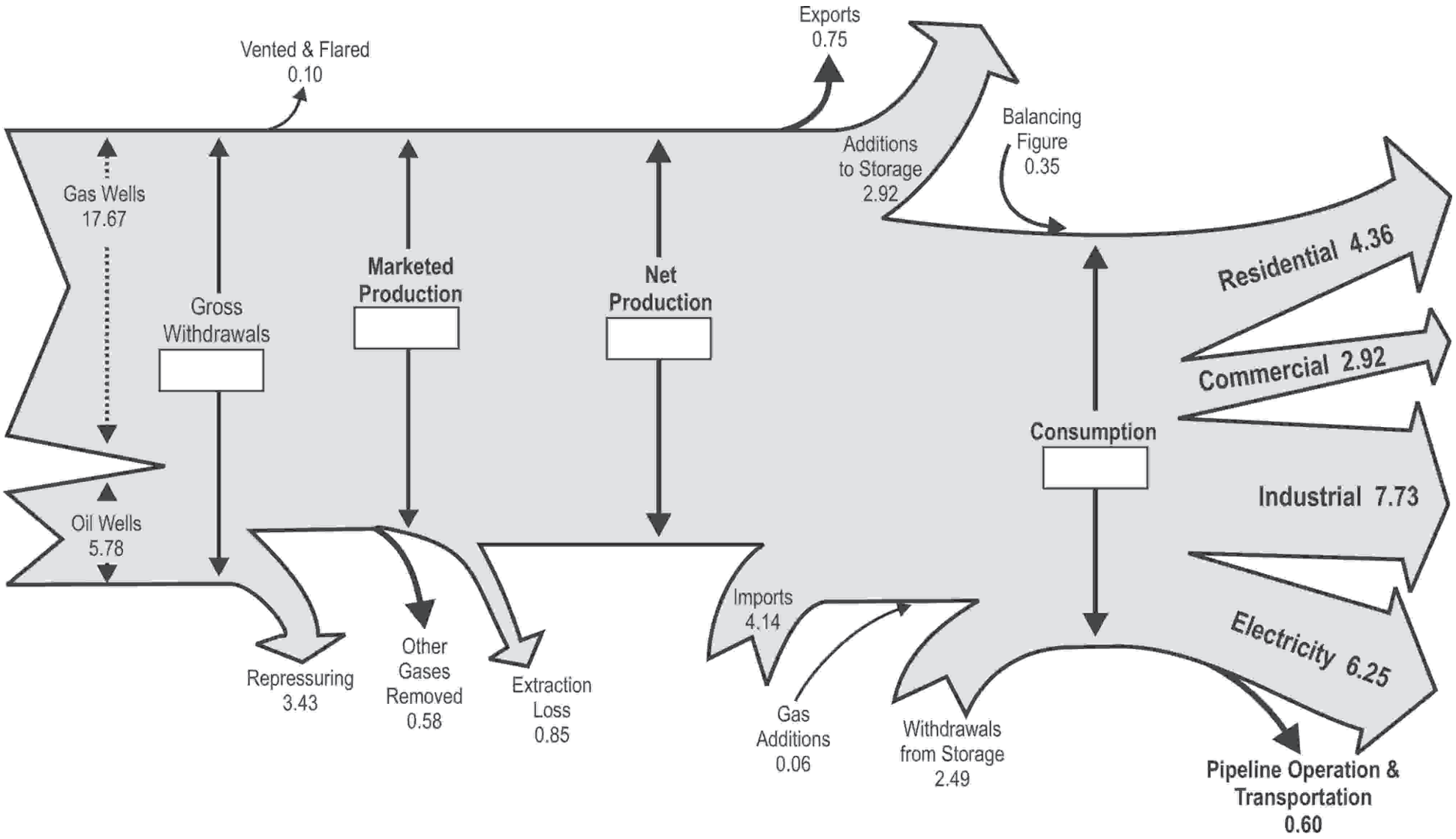


U.S. COAL FLOW 2006

PRODUCTION → CONSUMPTION

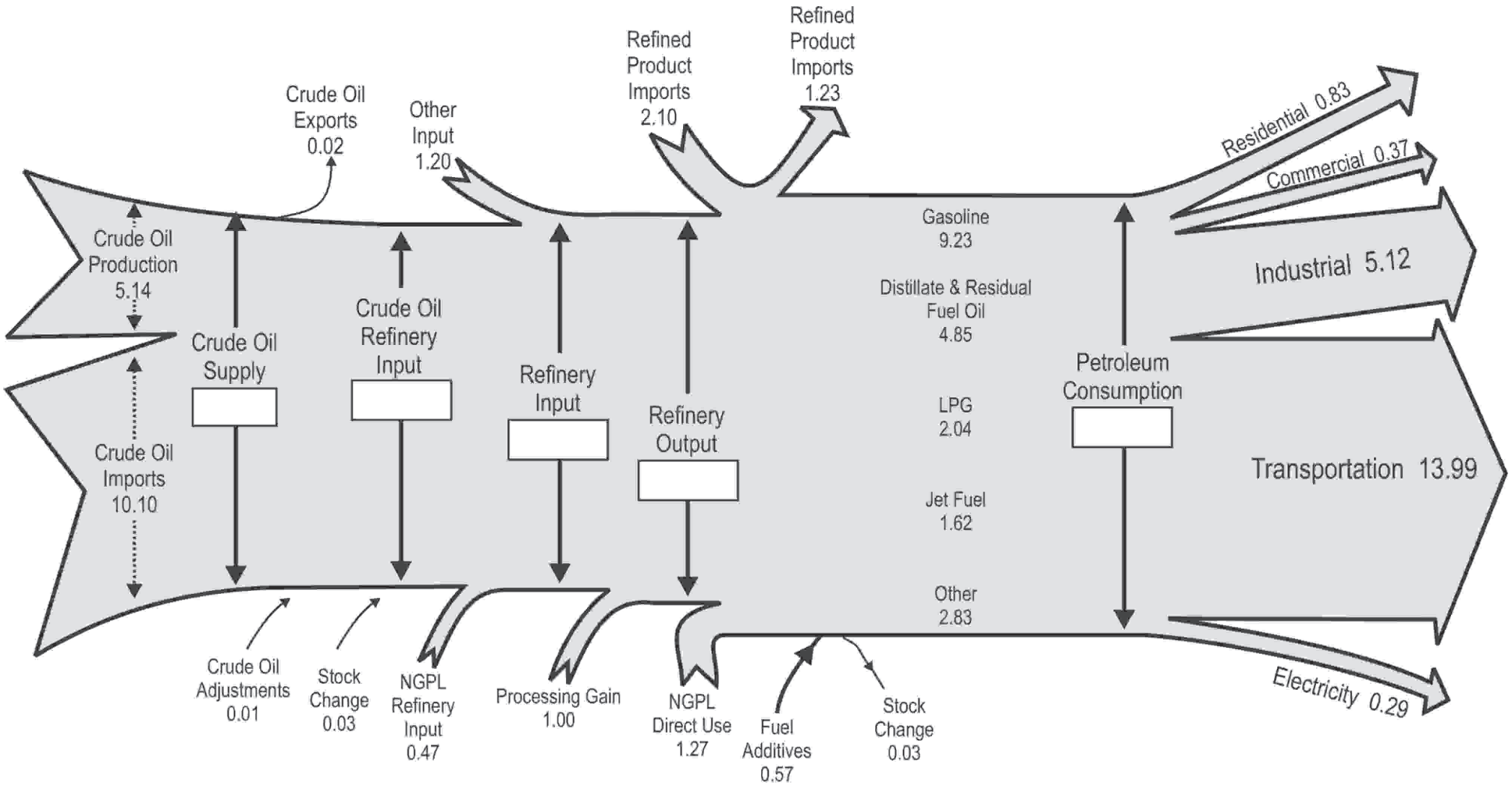
In million short tons



U.S. NATURAL GAS FLOW 2006

PRODUCTION → CONSUMPTION

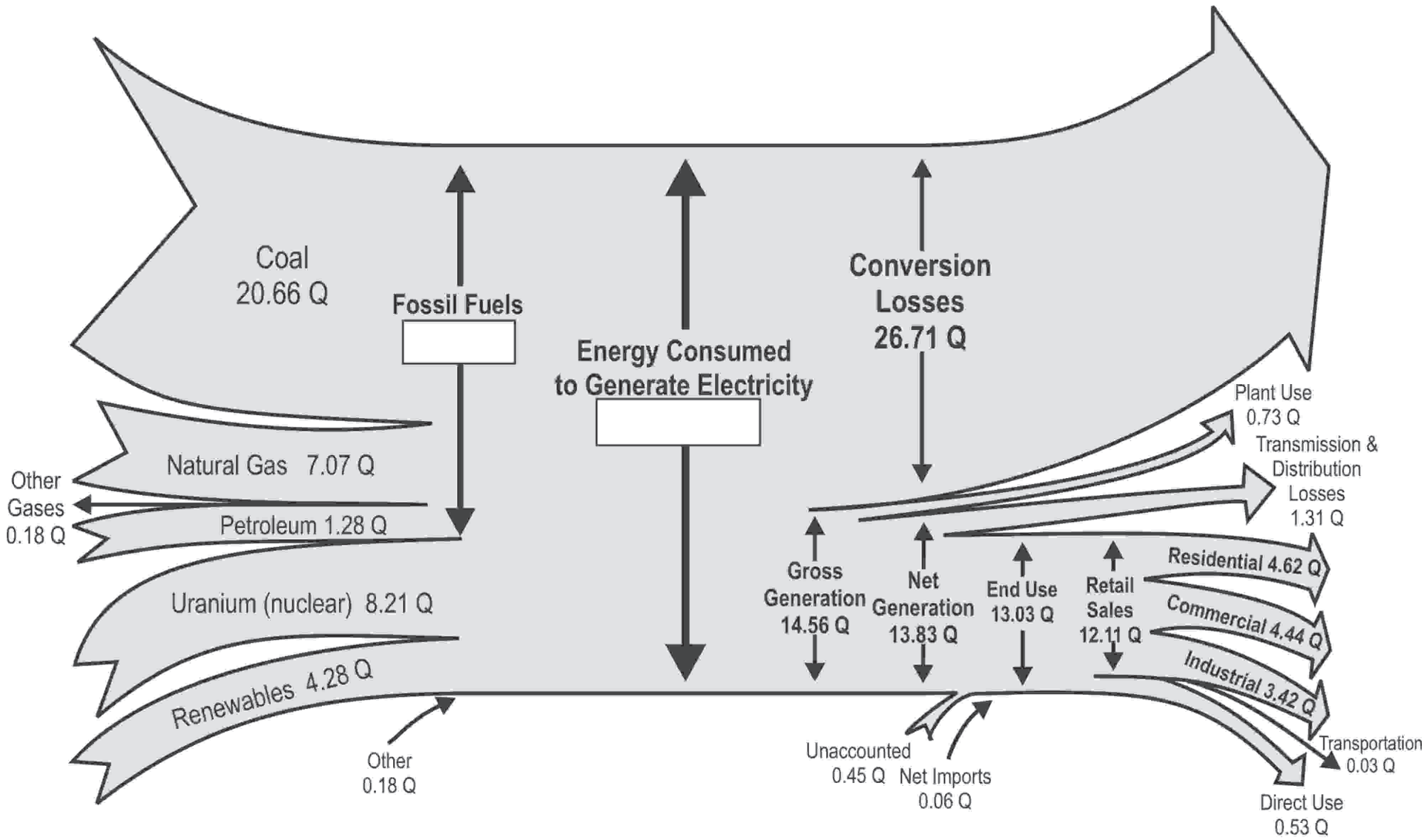
In trillion cubic feet



U.S. PETROLEUM (OIL) FLOW 2006

PRODUCTION → CONSUMPTION

In million barrels per day



U.S. ELECTRICITY FLOW 2006

PRODUCTION ⟶ CONSUMPTION

TRANSPORTATION SECTOR CONSUMPTION

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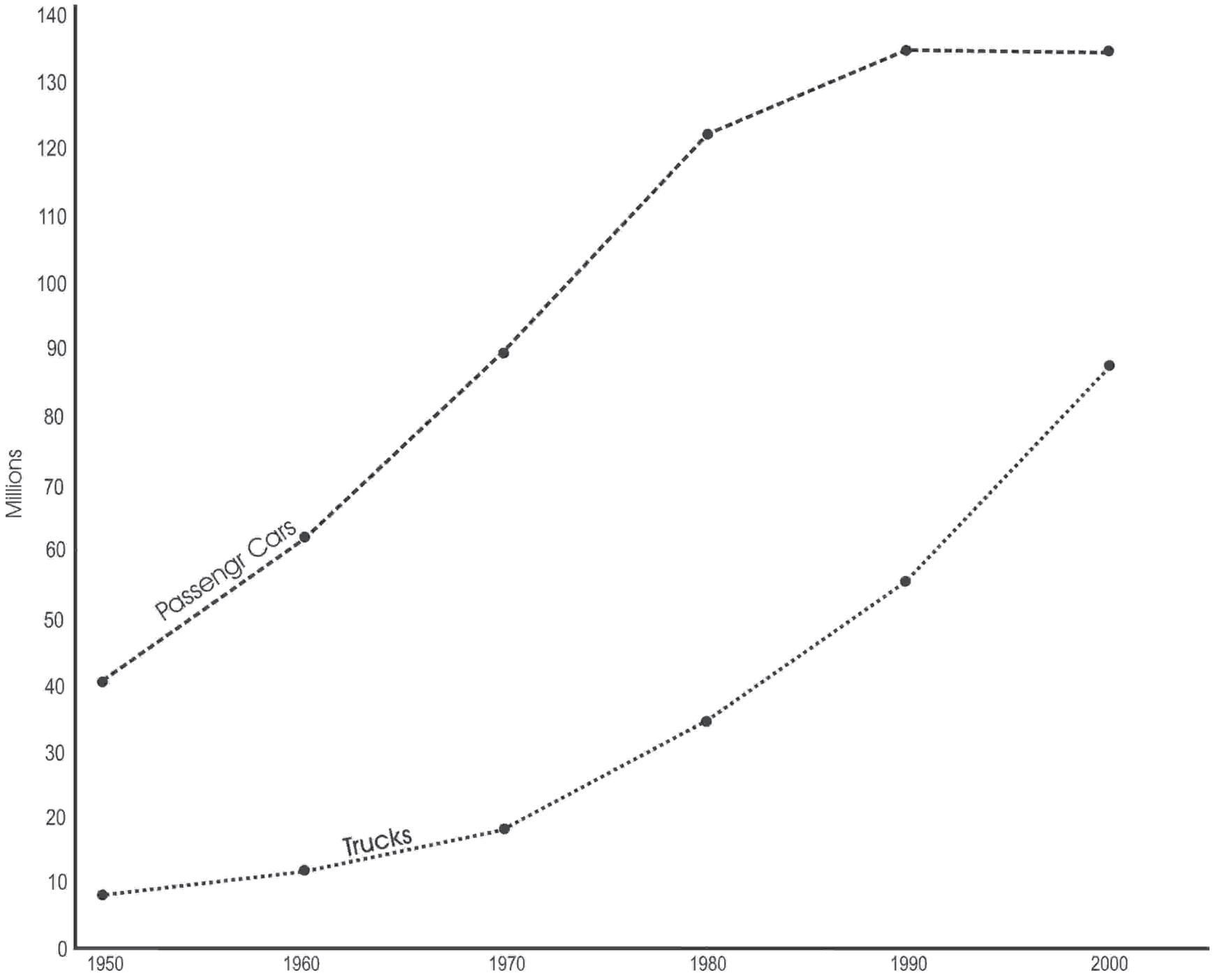
NUMBER OF VEHICLES



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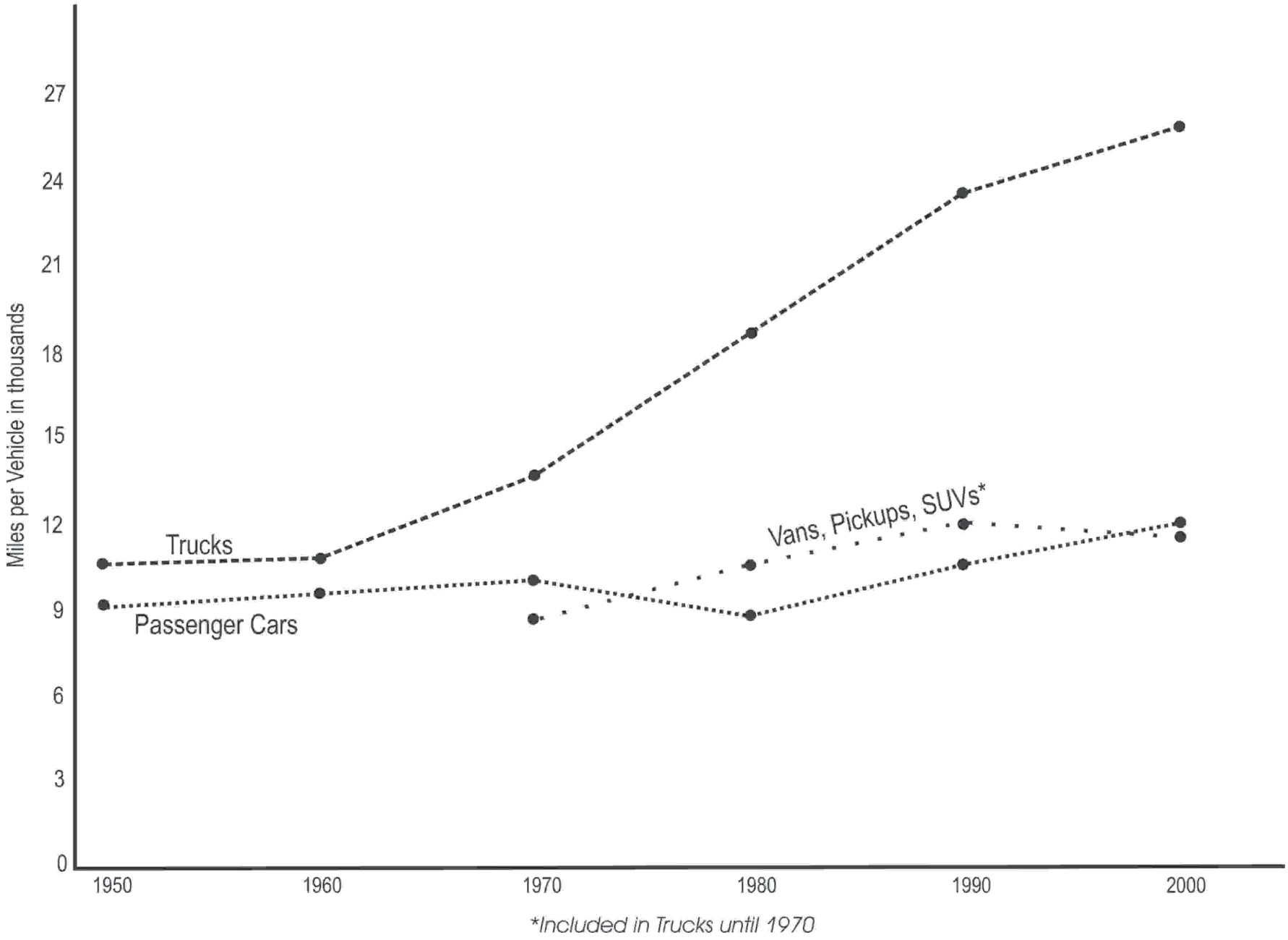
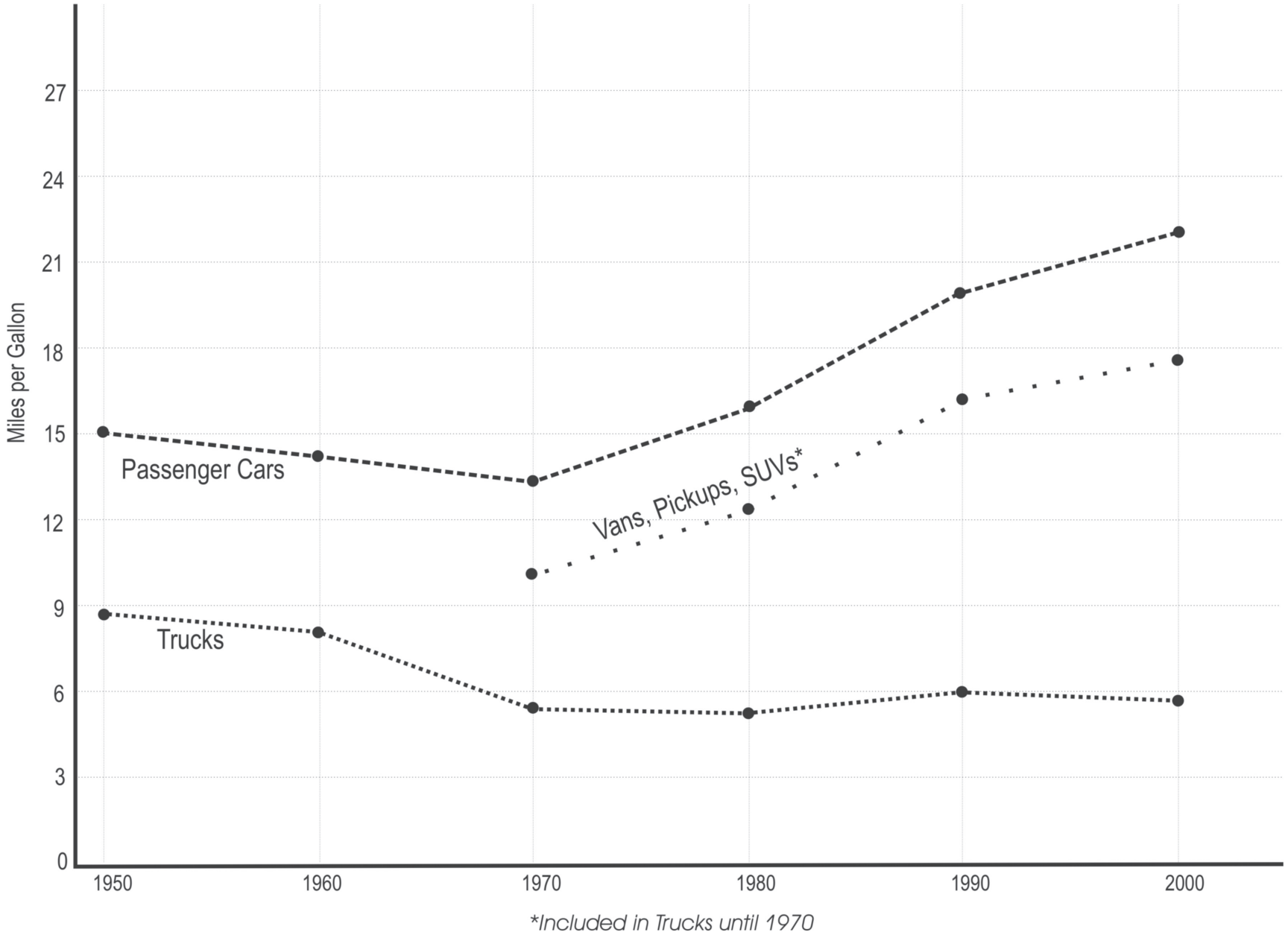
MOTOR VEHICLE MILEAGE



MOTOR VEHICLE FUEL ECONOMY



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ENERGY ANALYSIS
Evaluation Form

State: _____ Grade Level: _____ Number of Students: _____

1. Did you conduct the entire activity?	Yes	No
2. Were the instructions clear and easy to follow?	Yes	No
3. Did the activity meet your academic objectives?	Yes	No
4. Was the activity age appropriate?	Yes	No
5. Were the allotted times sufficient to conduct the activity?	Yes	No
6. Was the activity easy to use?	Yes	No
7. Was the preparation required acceptable for the activity?	Yes	No
8. Were the students interested and motivated?	Yes	No
9. Was the energy knowledge content age appropriate?	Yes	No
10. Would you use the activity again?	Yes	No

How would you rate the activity overall (excellent, good, fair, poor)?

How would your students rate the activity overall (excellent, good, fair, poor)?

What would make the activity more useful to you?

Other Comments:

Please fax or mail to:
NEED Project
PO Box 10101
Manassas, VA 20108
FAX: 1-800-847-1820

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